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A review of the status of the 4VWX flatfish stocks (exclusive of the halibuts)

by

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Abstract

Landings of flatfish (exclusive of the halibuts) in NAFO Divisions 4VWX remained at comparatively low levels in 1985 relative to those obtained in the late 1960's and early 1970's. While landings of flatfish in 1985 have decreased by almost 35% compared with 1984, it is doubtful whether this reflects decreased stock abundance. Recent (since 1982) indications from research vessel cruises suggest relatively stable population abundances for witch flounder and American plaice, but declining for yellowtail flounder. A multiplicative analysis of catch rates for the 4V American plaice fishery revealed an increasing trend since 1983, but the standardized series (comprised of directed catch rates only), included a relatively small proportion of all 4V American plaice landings. It was therefore concluded that there were insufficient grounds to suggest a change in the existing total allowable catch of 14,000 t.

Résumé

Dans les divisions 4VWX des zones de pêche de l'OPANO, les débarquements de poissons plats (à l'exception des flétans) sont restés à des niveaux relativement bas en 1985 par rapport à la fin des années 60 et au début des années 70. En 1985, les débarquements de poissons plats ont diminué de presque 35 % par rapport à 1984, mais il est difficile de dire si ceci reflète une baisse de l'abondance des stocks. Des indications récentes fournies (depuis 1982) par les navires de recherche indiquent une abondance relativement stable des populations de plie grise et de plie canadienne, mais un déclin des populations de limande à queue jaune. Une analyse multiplicative des taux de prise pour la pêche de la plie canadienne dans 4V a révélé une tendance à l'augmentation depuis 1983, mais les séries normalisées (comprenant uniquement les taux de prises dirigées) comprenaient une proportion relativement faible de tous les débarquements de plie canadienne dans 4V. On en a donc conclu qu'il y avait peu de raisons de suggérer une modification du total des prises admissibles, soit 14 000 t.

Introduction

Four members of the Pleuronectidae (exclusive of the halibuts) are exploited commercially on the Scotian Shelf. Listed in order of decreasing landings in 1985, they are:

American plaice (Hippoglossoides platessoides)
Witch flounder (Glyptocephalus cynoglossus)
Yellowtail flounder (Limanda ferruginea)
Winter flounder (Pseudopleuronectes americanus)

Of these, only American plaice, witch flounder and yellowtail flounder are under quota management. The landings of winter flounder, a coastal species, are comparatively low, only abundant along the Nova Scotia coast and in the Bay of Fundy. The only significant offshore fishery for winter flounder is around Sable Island (Halliday MS 1973).

The current assessment differs from those presented in past years inasmuch as catch rate analysis using a multiplicative model was completed for 4V plaice, the most important stock comprising the 4VWX flatfish fishery.

Patterns of Exploitation and Landings

Flatfish landings increased considerably from 14,463 t in 1963 to 55,256 t in 1968. Since then, fluctuations have occurred but catches have generally followed a declining trend (Fig. 1, Table 1). In the past 3 yr, the quota of 14,000 t was not reached.

American plaice typically comprise the largest fraction of all flatfish landings (Table 1) with catches in 4V making the largest contribution to the total plaice catch (Table 2). Although fish are landed throughout the year, the fishery is most active in the months May-July (Table 3). Since 1974, when 11,363 t were landed, catches of 4V plaice have declined. In 1985, 3897 t were landed. The majority of the landings were by Tonnage Class (TC) 5 (Tables 7, 11).

Witch flounder were usually the next largest contribution to the total flatfish landings. However, since 1971 when 17,864 t were landed, catches have decreased markedly with a low of 1473 t reported in 1982. In 1985, catches increased slightly, with 2086 t landed (Table 1). The witch flounder fishery traditionally operated in NAFO Divisions 4V and 4W (Table 4). However, since 1977, the catch from 4W has declined markedly. The gear employed in the 4VW witch fishery is now predominantly the Danish or Scottish seine (Tables 8, 12). Landings from vessels of TC2 comprise the largest fraction of total landings over the period 1980-1985.

Yellowtail flounder landings have remained stable over recent years (Table 1), but again are down from peak landings in the late 1960's, with 1014 t reported in 1985. NAFO Division 4V contributes the bulk of the landings (Table 5). Stern otter trawlers (TC5) account for the majority of the landings (Tables 9, 13).

Winter flounder annual landings have remained fairly constant from 1975-82, fluctuating between 1000 and 1400 t. In the last 3 yr, winter flounder landings have declined slightly (Table 6), with 823 t reported in 1985. Most of the winter flounder catches are taken by TC1 trawlers over the period 1980-1985 (Table 10).

Age Composition of the Commercial Catch

Commercial sampling for flatfish has included all four species, with the numbers of samples collected indicated in Tables 7-10. Age-size information (1948-78) for these stocks was provided by Cleary (MS 1979). While minimal sampling occurred prior to 1976, sampling has generally been adequate since. A notable exception to this has been 4V plaice in 1985. A new practice of fishermen is to land the catch in a "bob-tailed" condition, which has meant that port samplers have been unable to gather sample data such as lengths in the usual fashion. As a consequence, only eight commercial samples were obtained in 1985, none of which were from the most important gear class (Table 7). This problem will be circumvented in 1986 by incorporating use of a measuring board which accounts for the "bob-tailed" condition.

A further difficulty in developing a catch-at-age matrix for American plaice has been that many of the otoliths collected in 1982 have not yet been interpreted. Should this backlog be eliminated this year and sampling improve, it may be feasible to attempt an analytical assessment of this stock.

Indices of Abundance from the Commercial Fishery

American plaice

Previous assessments have provided CPUE indices based on catches by side trawlers (OTB1) of Tonnage Class 4. However, the contribution of this gear component to the total catch of 4V American plaice has been decreasing to the point that no catch was taken as "main species" in 1985 (Table 14). To circumvent this problem, we conducted a multiplicative analysis of catch rates (Gavaris 1980) using data from the side trawler TC4 and stern trawler TC4 and 5 fleets, the results of which are shown in Table 15. Only catch taken as "main species" was included. As the fishery is typically confined to a small part of the year which has not changed over the series, no seasonal effects were included in the model. The standardized catch rate series is shown in Table 15 and Fig. 2. The catch rates have been following an increasing trend since 1983. However, even the standardized series must be viewed with some caution, as a relatively small portion of total 4V American plaice landings are represented.

Witch and yellowtail flounder

Previously, the commercial CPUE index was calculated from catch per hour (t) of side otter trawlers, tonnage class 4. These data were chosen because catches are highest for this tonnage class and side otter trawlers had a complete data set. The months March-May were chosen due to consistently high catch rates over the years. Only those trips directed for flatfish species which had recorded effort and non-zero catches were included.

Data were smoothed using the '4253H' algorithm proposed by Tukey and developed by Velleman (1980). The algorithm consists of successive applications of running median smoothers followed by the Hamming running average:

$$Z(t) = 0.25\ y(t-1) + 0.5\ y(t) + 0.25\ y(t+1)$$

However, when the data extractions from previous years were re-examined, an error was found in the SPSS runs, such that catch and effort data from January were inadvertently included, along with March-May. New data series have been calculated for witch and yellowtail flounder and are presented in Fig. 3 and Table 16. However, the data series could not be completed for 1985, as there was little or no directed catch (catch taken as main species) from the side trawler TC4 fleet for either witch or yellowtail flounder. Both witch and yellowtail flounder commercial CPUE indices have been following an incresing trend since 1980. However, in recent years the indices are based on catches of 200 t or less. Hence, such series should be interpreted with caution, particularly for witch flounder.

Catch-Per-Unit-Effort Indices and Age Compositions from Research Cruises

A significant problem was found with past assessments (since 1979) in the reporting of "stratified mean catch per tow" from the research vessel surveys. The data apparently were extracted from printouts which gave simple, not stratified, means. New catch rates have been developed using the 'STRAP' program following the method described below.

Catch rates from 1970-81 were calculated using data from cruises conducted during the summer months onboard the A.T. Cameron. In 1982, the data were collected from a cruise on the Lady Hammond and since 1983, from the Alfred Needler. The indices of abundance, stratified mean catch per tow (numbers and weight), were obtained by use of the 'STRAP' program for analyses of research cruise data. No conversion factor was used between the catch rate series of American plaice from the Lady Hammond and the Alfred Needler cruises. Following the recommendation made at the fall, 1984 CAFSAC Statistics, Sampling and Surveys Subcommittee Meeting, the proportion of total American plaice catch taken in 1982 $<$28 cm was multiplied by 0.7 to account for differences in the fishing performance between A.T. Cameron and Lady Hammond.

The new series are shown in Table 16 and Fig. 4. American plaice indices have been stable since 1983, with witch flounder increasing slightly. However, the index for yellowtail flounder has been decreasing since 1982. The series were smoothed using the previously defined algorithm. The stratified catch at age for 4V American plaice is given in Table 17. The 1972 and 1977 year-classes appeared strong.

Recruitment

We calculated recruitment of American plaice using a formula suggested by Dale and O'Boyle (MS 1983):

$$R = \frac{\frac{X_3}{\overline{X_3}} + \frac{X_4}{\overline{X_4}}}{2}$$

where X_3 = catch-at-age 3 (year t)
X_4 = catch-at-age 4 (year t+1 for the same cohort).

The index was calculated separately for males and females and the data are shown in Table 17. A time series plot of the index is also provided (Fig. 5). The recruitment index has declined since 1977.

Conclusions and Recommendations

A recurring issue with this assessment has been the use and reliability of commercial CPUE indices. The 4VWX flatfish fisheries are increasingly bycatch in nature and indices of abundance based on main species catch are becoming unreliable due to the small number of observations available. In the case of 4V American plaice, use of a multiplicative analyses became obligatory to provide a complete time series. We expect that indices of abundance obtained from research vessel cruises will become increasingly significant in future years.

Errors in the previous calculations of commercial and RV indices of abundance were also found this year. However, it is unlikely that those errors would have affected the advice that the Groundfish Subcommittee tendered in past years, as the corrected indices of abundance tend to track the previous ones.

While landings of flatfish are down almost 35% over last year's level, it is doubtful whether this reflects decreased stock abundance. Indices of abundance available from the commercial fishery and research surveys are generally stable (with the exception of yellowtail flounder), including those of the most important stock, 4V plaice. It seems more likely that decreased catches reflect decreased effort towards those species, a view borne out by Fig. 6 (showing trends in landings of 4V American plaice taken as main species) and discussions with port sampling technicians and personnel with DFO Allocation Branch. Therefore, there are no grounds to suggest a change to the existing total allowable catch of 14,000 for 4VWX flatfish.

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Table 1. Total landings (t) for 4VWX flatfish between 1963-85.

Year	American plaice	Witch flounder	Yellowtail flounder	Winter flounder	Flatfish (N.S.)	Total
1963	2309	7486	3972	696	-	14,463
1964	3082	8629	5399	1311	194	18,615
1965	8198	12943	6104	1339	90	28,674
1966	14206	14512	4851	1346	30	34,945
1967	10770	7816	5196	944	-	24,726
1968	19265	21682	13128	1181	-	55,256
1969	13735	14093	3826	1416	-	33,070
1970	8358	6048	3682	1530	11	19,629
1971	14301	17864	1775	3084	1	37,025
1972	10653	11351	1485	1454	723	25,666
1973	12432	13969	1513	1909	873	30,696
1974	16772	7415	939	2756	817	28,699
1975	11747	8922	1568	1374	1122	24,733
1976	11147	5742	904	1297	1043	20,133
1977	7752	2431	1443	1257	944	13,827
1978	6756	2291	1628	1207	1060	12,942
1979	6354	2071	2090	1088	1303	12,906
1980	7572	2321	2491	1174	1887	15,445
1981	6772	1741	2889	1448	1577	14,427
1982	5697	1473	2623	1236	1774	12,803
1983[1]	6106	1662	2423	995	2071	13,257
1984[1]	5854	1748	2325	877	2001	12,805
1985[1]	4353	2086	1014	823		8,276

[1]Provisional (Maritime catches only).

Table 2. American plaice landings (t) for NAFO Division 4VWX for 1963-85.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	1376	683	250	2309	2108	(91)[2]	201	(9)
1964	1967	603	512	3082	2838	(92)	244	(8)
1965	4707	2797	694	8198	5542	(68)	2656	(32)
1966	8167	5313	726	14206	9113	(64)	5093	(36)
1967	8884	780	1106	10770	10524	(98)	246	(2)
1968	10489	7830	946	19265	9828	(51)	9437	(49)
1969	8076	4789	870	13735	9300	(68)	4435	(32)
1970	5242	2481	635	8358	6303	(75)	2055	(25)
1971	7765	5991	545	14301	7513	(53)	6788	(47)
1972	6912	3175	566	10653	6855	(64)	3798	(36)
1973	8686	3407	339	12432	5146	(41)	7286	(59)
1974	11363	4951	458	16772	6967	(42)	9805	(58)
1975	7336	4115	296	11747	6623	(56)	5124	(44)
1976	8488	2350	309	11147	6932	(62)	4215	(38)
1977	6711	592	449	7752	7654	(99)	98	(1)
1978	5501	743	512	6756	6679	(99)	77	(1)
1979	5028	498	828	6354	6329	(100)	25	(0)
1980	6293	598	681	7572	7490	(99)	82	(1)
1981	5677	581	514	6772	6586	(97)	186	(3)
1982	4920	400	377	5697	5621	(99)	76	(1)
1983[1]	5094	428	584	6106	5963	(98)	143	(2)
1984[1]	5351	283	220	5854	5780	(99)	74	(1)
1985[1]	3897	174	282	4353	4353	(100)	-	

[1]All countries except USA.
[2]Percentage of total catch.

Table 3. 4V plaice - Canadian (Maritimes only) catch by month (1978-1985).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1978	33	292	319	775	912	683	889	315	176	259	222	126	5001
1979	150	240	549	570	532	426	596	323	197	272	371	654	4880
1980	143	392	512	418	979	875	801	491	232	455	319	289	5906
1981	75	593	358	246	648	709	524	387	486	523	337	395	5281
1982	54	229	269	244	652	580	583	447	611	402	304	351	4726
1983	306	323	224	148	566	1080	742	738	306	264	118	105	4920
1984	220	45	293	352	739	820	661	601	456	378	311	474	5350
1985	247	128	256	323	298	320	649	524	459	250	111	200	3765
Total	1228	2242	2780	3076	5326	5493	5445	3826	2923	2803	2093	2594	39829

Table 4. Witch flounder landings (t) for NAFO Division 4VWX for 1963-85

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	4971	2440	75	7486	6972	(93)[2]	514	(7)
1964	5808	2564	257	8629	8406	(97)	223	(3)
1965	5068	7454	421	12943	7710	(60)	5233	(40)
1966	5241	9047	224	14512	7046	(49)	7466	(51)
1967	5740	1693	383	7816	7496	(96)	320	(4)
1968	7598	13349	735	21682	8772	(40)	12910	(60)
1969	4338	8963	792	14093	6671	(47)	7422	(53)
1970	3282	1959	807	6048	4920	(81)	1128	(19)
1971	5640	11083	1141	17864	6816	(38)	11048	(62)
1972	4894	5759	698	11351	5909	(52)	5442	(48)
1973	6572	6862	535	13969	5854	(42)	8115	(58)
1974	4913	2004	498	7415	5830	(79)	1585	(21)
1975	3284	5307	331	8922	3406	(38)	5516	(62)
1976	2718	2683	341	5742	2466	(43)	3276	(57)
1977	1555	455	421	2431	2307	(95)	124	(5)
1978	1540	563	188	2291	2139	(93)	152	(7)
1979	1572	209	290	2071	2057	(99)	14	(1)
1980	1801	189	331	2321	2298	(99)	23	(1)
1981	1123	156	462	1741	1687	(97)	54	(3)
1982	789	101	583	1473	1411	(96)	62	(4)
1983[1]	877	126	659	1662	1473	(89)	189	(11)
1984[1]	1168	149	431	1748	1714	(98)	34	(2)
1985[1]	1583	52	451	2086	2086	(100)	-	

[1]All countries except USA.
[2]Percentage of total catch.

Table 5. Yellowtail flounder catch (t) for NAFO Division 4VWX for 1963-85.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	1740	2148	84	3972	3784	(95)[2]	188	(5)
1964	4084	1165	150	5399	5288	(98)	111	(2)
1965	4330	1550	224	6104	5378	(88)	726	(12)
1966	3521	1164	166	4851	3770	(78)	1081	(22)
1967	3808	1163	225	5196	5152	(99)	44	(1)
1968	6953	5970	205	13128	5377	(41)	7751	(59)
1969	2491	1134	201	3826	1263	(33)	2563	(67)
1970	670	2686	326	3682	947	(26)	2735	(74)
1971	889	668	218	1775	1033	(58)	742	(42)
1972	697	624	164	1485	1007	(68)	478	(32)
1973	980	394	139	1513	424	(28)	1089	(72)
1974	573	130	236	939	593	(63)	346	(37)
1975	1101	254	213	1568	1083	(69)	485	(31)
1976	473	201	230	904	610	(67)	294	(33)
1977	1101	40	302	1443	1424	(99)	19	(1)
1978	1085	156	387	1628	1610	(99)	18	(1)
1979	1655	144	291	2090	2088	(100)	2	(0)
1980	2158	78	255	2491	2486	(100)	5	(0)
1981	2539	123	227	2889	2881	(100)	8	(0)
1982	2360	51	212	2623	2620	(100)	3	(0)
1983[1]	2043	59	321	2423	2422	(100)	1	(0)
1984[1]	2112	50	163	2325	2319	(100)	6	(0)
1985[1]	932	9	73	1014	1014	(100)	-	(0)

[1]All countries except USA.
[2]Percentage of total catch.

Table 6. Winter flounder catch (t) for NAFO Division 4VWX for 1963-85.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	17	65	614	696	668	(96)[2]	28	(4)
1964	12	19	1280	1311	1282	(98)	29	(2)
1965	32	179	1128	1339	1237	(92)	102	(8)
1966	55	34	1257	1346	997	(74)	349	(26)
1967	37	5	902	944	926	(98)	18	(2)
1968	10	28	1143	1181	1128	(96)	53	(4)
1969	4	12	1400	1416	1392	(98)	24	(2)
1970	8	44	1478	1530	1480	(97)	50	(3)
1971	237	1364	1483	3084	1430	(46)	1654	(54)
1972	78	551	825	1454	824	(57)	630	(43)
1973	480	655	774	1909	904	(47)	1005	(53)
1974	777	1005	974	2756	1321	(48)	1435	(52)
1975	179	525	670	1374	802	(58)	572	(42)
1976	235	345	717	1297	908	(70)	389	(30)
1977	226	9	1022	1257	1244	(99)	13	(1)
1978	186	137	884	1207	1202	(100)	5	(0)
1979	228	13	847	1088	1085	(100)	3	(0)
1980	30	10	1134	1174	1173	(100)	1	(0)
1981	26	11	1411	1448	1448	(100)	-	
1982	82	10	1144	1236	1231	(100)	5	(0)
1983[1]	72	8	915	995	992	(100)	3	(0)
1984[1]	2	5	870	877	877	(100)	-	(0)
1985[1]	27	2	794	823	823	(100)	-	(0)

[1]All countries except USA.
[2]Percentage of total catch.

Table 7. Nominal catch (t) of American plaice by gear in NAFO Division 4V for all countries, 1972-85 (# of Canadian commercial fishery samples indicated in parentheses).

Year	Side otter trawl	Stern otter trawl[3]	Danish and Scottish seine	Longline	Other[1]	Total
1972	3012 (4)	3267	364	189	80	6912 (4)
1973	1971 (2)	5987 (2)	482	152	94	8686 (4)
1974	2193 (7)	8318	510	125	217	11363 (7)
1975	2779 (5)	3455 (1)	657	171	274	7336 (6)
1976	2438 (4)	4678 (3)	1178 (8)	87	107	8488 (15)
1977	2661 (5)	2285 (4)	1443 (17)	218	104	6711 (26)
1978	1766 (9)	2150 (6)	1222 (11)	164	199	5501 (26)
1979	1745 (11)	2201 (4)	806 (1)	192	84	5028 (16)
1980	1871 (12)	2674 (9)	1523 (3)	211	14	6293 (24)
1981	2080 (14)	2222 (7)	941 (1)	431 (4)	3	5677 (26)
1982	1868 (12)	1546 (8)	716 (3)	786 (1)	4	4920 (24)
1983[2]	1159 (1)	2191(14)	1020 (7)	716 (2)	8	5094 (24)
1984[2]	1262 (4)	2228(11)	1265 (1)	564 (3)	32	5351 (19)
1985[2]	46 (2)	2504	715 (4)	615 (2)	17	3897 (8)

[1]Includes NK and MISC gears.
[2]All countries except USA.
[3]On the basis of purchase slip information and log records, catches recorded as unspecified otter trawl were assumed to be from stern otter trawlers. This assumption also holds for data in Tables 7-9.

Table 8. Nominal catch (t) of witch flounder by gear in NAFO Division 4VW for all countries, 1972-85 (# of Canadian commercial fishery samples taken indicated in parentheses).

Year	Side otter trawl	Stern otter trawl	Danish & Scottish seine	Other[1]	Total
1972	2459 (2)	6925	1257 (2)	12	10,653 (4)
1973	2194 (2)	9700 (1)	1464 (1)	76	13,434 (4)
1974	1968 (4)	3675 (2)	1221 (2)	53	6,917 (8)
1975	1121 (5)	6360 (4)	995 (1)	115	8,591 (10)
1976	751	3709 (2)	869 (12)	72	5,401 (14)
1977	272 (2)	785 (6)	838 (8)	115	2,010 (16)
1978	406 (11)	715 (3)	930 (12)	52	2,103 (26)
1979	419 (1)	512 (1)	792 (7)	58	1,781 (9)
1980	290 (7)	791 (5)	866 (5)	43	1,990 (17)
1981	342 (6)	354 (3)	564 (1)	19	1,279 (10)
1982	164 (1)	209 (1)	511 (2)	6	890 (4)
1983[2]	95	217 (6)	678 (6)	13	1003 (12)
1984[2]	39 (3)	246 (5)	1012 (2)	20	1317 (10)
1985[2]	9 (1)	401 (2)	1190 (7)	34	1634 (10)

[1]Includes NK and MISC gears.
[2]All countries except USA.

Table 9. Nominal catch (t) of yellowtail flounder by gear in NAFO Division 4VWX for all countries, 1972-85 (# of Canadian commercial fishery samples taken indicated in parentheses).

Year	Side otter trawl	Stern otter trawl	Danish and Scottish seine	Longline	Other[1]	Total
1972	787 (1)	622	63	11	2	1485 (1)
1973	327 (1)	1094	71	20	1	1513 (1)
1974	208 (1)	640	56	32	3	939 (1)
1975	647	832 (1)	40	49	-	1568 (1)
1976	209	610	61	24	-	904
1977	769 (3)	444 (3)	141	14	75	1443 (6)
1978	684 (6)	729 (1)	92 (3)	18	105	1628 (10)
1979	1239	653	132	42	24	2090
1980	1306 (10)	837 (6)	299	11	38	2491 (16)
1981	1622 (19)	1032 (10)	174	13	48	2889 (29)
1982	1853 (18)	694 (7)	62	14	-	2623 (25)
1983	1390 (9)	746 (19)	187	32	68	2423 (28)
1984[2]	1230 (6)	727 (12)	316	36	16	2319 (18)
1985[2]	10 (1)	673	243	83	5	1014 (1)

[1]Includes NK and MISC gears.
[2]All countries except USA.

Table 10. Nominal catch (t) of winter flounder by gear in NAFO Division 4VWX for all countries, 1972-85 (# of Canadian commercial fishery samples taken in parentheses).

Year	Side otter trawl	Stern otter trawl	Longline	Danish and Scottish seine	Other[1]	Total
1972	249	1135	39	1	30	1454
1973	527 (2)	1290	39	2	51	1909 (2)
1974	784	1818	2	98	54	2756
1975	456	810	14	32	62	1374
1976	546 (10)	661 (1)	41	15	34	1297 (11)
1977	566	480 (3)	40	2	169	1257 (3)
1978	512	575	50	8	62	1207
1979	290	635 (1)	70	18	75	1088 (1)
1980	2 (1)	962	52	21	137	1174 (1)
1981	18	1303 (9)	57	8	62	1448 (9)
1982	72	1064 (13)	35	7	58	1236 (13)
1983[2]	-	882 (13)	16	7	90	995 (13)
1984[2]	2	730 (13)	6	5	134	877 (13)
1985[2]	11	713 (6)	3	10	86	823 (6)

[1]Includes NK and MISC gears.

[2]All countries except USA.

Table 11. American plaice-4V catch by gear by tonnage class by year (Maritimes only), 1978-85.

	OTB 1			OTB 2			LL			DS/SS			Others		
	≤ 3	4	5	≤ 3	4	5	≤ 3	4	5	≤ 3	4	5	≤ 3	4	5
1978	59	1385	3	50	47	1880	162	3	-	1205	-	-	18	69	116
1979	76	1562	-	74	358	1670	191	-	2	803	1	-	84	26	-
1980	29	1627	33	108	624	1712	208	-	2	1502	-	-	59	-	-
1981	31	1825	-	116	767	1168	406	8	-	932	-	-	26	-	-
1982	3	1714	-	528	508	452	847	2	-	715	-	-	57	-	-
1983	2	1157	-	397	663	950	692	2	-	1024	-	-	32	-	-
1984	0	1261	-	395	674	1157	564	-	-	1265	-	-	32	-	-
1985	-	43	-	153	565	1659	613	2	-	714	-	-	15	-	-

Table 12. Witch 4VW - catch by gear by tonnage class (Maritimes only), 1978-85.

	OTB 1			OTB 2			LL			DS/SS			Others		
	< 3	4	5	< 3	4	5	< 3	4	5	< 3	4	5	< 3	4	5
1978	17	202	-	21	20	371	20	-	-	914	-	-	19	7	8
1979	11	189	-	-	99	302	42	-	-	791	-	-	16	-	-
1980	9	212	-	4	255	456	56	-	-	841	-	-	4	-	-
1981	1	287	-	23	80	167	-	-	-	555	-	-	13	-	-
1982	-	136	-	23	54	102	2	-	-	507	-	-	4	-	-
1983	-	87	-	16	32	96	10	-	-	671	-	-	13	-	-
1984	-	39	-	31	41	140	7	-	-	1013	-	-	13	-	-
1985	-	9	-	26	88	287	31	-	-	1190	-	-	4	-	-

Table 13. Yellowtail-4VWX catch by gear by tonnage class by year (Maritimes only), 1978-85.

	OTB 1				OTB 2				LL				DS/SS				Others			
	≤ 3	4	5	6	≤ 3	4	5	6	≤ 3	4	5	6	≤ 3	4	5	6	≤ 3	4	5	6
1978	85	569	-	-	113	9	504	-	15	-	-	-	91	-	-	-	102	38	43	-
1979	113	1063	-	-	114	133	371	-	41	-	-	-	149	-	-	-	7	2	-	-
1980	106	1038	15	-	148	283	360	-	14	-	-	-	296	-	-	-	31	-	-	-
1981	92	1490	-	-	156	352	445	-	14	-	-	-	173	-	-	-	48	-	-	-
1982	22	1820	-	-	363	143	126	-	16	-	-	-	61	-	-	-	-	-	-	-
1983	-	1391	-	-	269	230	126	-	35	-	-	-	188	-	-	-	67	-	-	-
1984	-	1230	-	-	279	260	181	-	37	-	-	-	316	-	-	-	16	-	-	-
1985	-	-	-	-	88	127	403	-	83	-	-	-	242	-	-	-	6	-	-	-

Table 14. Input data for multiplicative analysis, 4V American plaice, 1968-85.

Year	OTB1 TC 4 Catch (t)	OTB1 TC 4 Effort (hr)	OTB2 TC 4 Catch (t)	OTB2 TC 4 Effort (hr)	OTB2 TC 5 Catch (t)	OTB2 TC 5 Effort (hr)
1968	1542	4967	0[1]	0[1]	161	507
1969	735	2202	29	74	597	1817
1970	246	848	198	404	184	480
1971	417	1724	174	635	113	551
1972	742	1883	0[1]	0[1]	173	565
1973	279	1234	36	416	98	576
1974	658	2733	43	178	569	2057
1975	520	1889	68	221	668	1441
1976	329	1463	64	217	359	1144
1977	779	2684	11	111	334	1343
1978	428	1768	25	127	477	1498
1979	445	1915	113	608	241	638
1980	314	2252	113	691	227	452
1981	244	1256	30	80	98	223
1982	127	881	2[1]	13[1]	10[1]	7[1]
1983	152	1511	5[1]	8[1]	5[1]	8[1]
1984	298	1287	20	148	17	42
1985	0[1]	0[1]	10	12	95	99

[1]Values excluded from the multiplicative analysis.

Table 15. Results of multiplicative analysis, 4V American plaice, 1968-1985.

regression of multiplicative model

ltiple r..... 0.849
ltiple r squared..... 0.721

analysis of variance

source of variation	df	sums of squares	mean squares	f value
intercept	1	8.103e1	8.103e1	
regression	19	7.795e0	4.103e-1	3.678
type 1	2	9.481e-1	4.741e-1	4.249
type 2	17	6.202e0	3.648e-1	3.270
residuals	27	3.012e0	1.116e-1	
total	47	9.184e1		

regression coefficients

variable	coefficient	std. error	no. obs.
intercept	-1.283	0.244	47
1	-0.096	0.127	14
2	0.249	0.121	16
3	0.183	0.307	3
4	0.262	0.307	3
5	-0.201	0.307	3
6	0.101	0.334	2
7	-0.670	0.307	3
8	-0.144	0.307	3
9	0.153	0.307	3
10	-0.059	0.307	3
11	-0.415	0.307	3
12	-0.164	0.307	3
13	-0.140	0.307	3
14	-0.258	0.307	3
15	0.085	0.307	3
16	-0.654	0.414	1
17	-1.014	0.414	1
18	-0.224	0.307	3
19	1.095	0.340	2

Table 16a. American plaice research[1] CPUE in NAFO Division 4V for 1970-85.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Research																
#/tow	79.83	79.11	70.79	40.75	98.66	60.69	82.56	57.21	26.16	88.46	115.84	90.70	75.91	83.16	97.43	69.93
Smoothed	79.83	76.67	73.43	70.55	68.29	66.68	66.75	68.09	72.30	80.81	87.21	88.61	87.15	83.92	80.90	78.05

Table 16b. Witch flounder commercial and research[1] CPUE in NAFO Division 4VW for 1970-85.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Canadian OTB1/TC4																
(t/h)	.137	.161	.182	.251	.243	.126	.059	.016	.076	.065	.049	.022	.236	.242	.097	
Smoothed	.192	.192	.193	.194	.180	.136	.083	.057	.051	.051	.070	.107	.125	.125	.125	
Research																
#/tow	2.27	6.06	4.26	9.11	19.35	5.55	2.82	3.48	3.10	1.64	3.44	3.80	3.43	3.80	3.44	4.55
Smoothed	2.27	5.23	7.18	7.75	7.47	6.22	4.40	3.38	3.21	3.24	3.33	3.48	3.59	3.68	3.88	4.21

Table 16c. Yellowtail flounder commercial and research[1] CPUE in NAFO Division 4VWX for 1970-85.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Canadian OTB1/TC4																
(t/h)	.133	.340	.276	.125	.103	.203	.125	.087	.139	.181	.160	.176	.344	.332	.244	
Smoothed	.212	.217	.211	.186	.147	.126	.123	.125	.135	.152	.181	.224	.255	.262	.262	
Research																
#/tow	4.68	17.94	4.84	4.42	6.40	6.53	21.67	50.84	4.08	5.68	13.27	18.85	25.67	11.39	3.38	3.96
Smoothed	4.68	4.68	4.81	5.06	6.93	10.74	13.13	13.28	12.94	12.77	13.28	14.31	14.49	11.86	7.19	3.96

[1]Summer cruises, values calculated using the "STRAP" program.

Table 17. Stratified mean catch per tow at age (number), calculated for American plaice from summer bottom trawl surveys in NAFO Division 4V, 1970-1985. The recruitment index (see text for calculation) is also shown for both males and females.

AGES	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
								Males								
1	0	0	0	0	0	0	0	0.05	0	0.29	0.02	0	0	0.01	0	0.27
2	0.06	0.48	0.81	0.23	1.72	0.74	0.3	0.12	0.16	1.26	0.35	0.42	1	0.53	0.88	0.83
3	2.49	1.02	1.88	1.44	2.81	5.31	3.71	1.14	0.09	1.85	5.88	1.57	2.04	2.29	0.78	3.07
4	4.49	6.49	0.98	1.26	3.28	2.82	18.6	2.56	0.83	2.97	2.22	11.6	4.39	3.85	5.31	2.84
5	11.8	8.45	5.36	1.19	5.7	2.97	6.16	6.1	1.33	8.79	3.62	2.78	8.56	4.55	7.84	5.03
6	8.31	11.5	5.15	3.08	1.65	1.74	6.52	2.02	2.99	6.45	8.37	1.86	5.12	8.23	5.12	3.56
7	7	6.77	10.1	3.83	6.4	1.68	4.43	3.02	1.77	11.4	11	7.49	4.73	3.56	12	3.37
8	5.07	5.04	4	5.52	10.1	4.09	5.26	3.03	1.57	4.87	15.5	5.56	3.78	2.93	4.84	3.59
9	2.6	3.62	2.33	2.2	8.44	2.83	8.1	4.03	1.29	4.25	8.08	6.66	3.32	3.65	2.46	3.71
10	0.89	1.62	2.2	0.95	4.2	3.48	6.29	2.23	1.49	3.5	4.68	2.29	2.76	3.16	5.39	2.49
11	0.81	0.92	0.69	0.82	1.77	2.39	2.4	0.76	0.87	1.79	2.82	0.87	0.26	2.31	1.88	1.87
12	0.38	0.73	0.58	0.32	2.27	0.68	1.55	0.49	0.93	1.53	2.33	0.58	0.06	0.71	1.77	1.49
13	0.07	0.29	0.12	0.1	0.28	1.11	0.47	0.16	0.03	0.55	0.85	0.45	0.24	0.31	1.94	0.55
14	0.17	0.52	0.1	0.09	0.16	0.18	0.08	0.21	0.05	0.05	0.06	0.65	0.39	0.53	0.58	1.09
15	0.15	0.4	0.22		0.05	0.36	0.03	0.08	0.05	0.08	0.03	0.65	0	0.21	0.22	0.19
16	0	0.27	0.11		0.02	0.09		0.02				0.28	0.13	0.21	0.06	0.14
17	0	0	0		0	0.12						0.21	0.06	0	0.02	
18	0	0			0.07								0.06	0		
19	0	0.07			0.04									0		
20	0.02													0.09		
21																
22																
23																
24																
25																
NK	0.17	0	0.05	0.32	0.55	0.33	0.03	0.08	0	0	0	0.06	0.16	0.02	0	0.14
Total	44.3	48.2	34.7	21.4	49.5	30.9	63.9	26.1	13.5	49.7	65.8	44	37.1	37.2	51.1	34.2
Rec. Indices (male)			0.54	0.66	0.9	3.13	1.07	0.33	0.34	0.63	2.51	0.81	0.85	1.06	0.47	
								Females								
AGES	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.18	0	0.2
2	0	0.27	0.24	0.18	1.42	0.23	1	0.01	0.05	0.42	0.69	0.29	1.99	0.74	0.63	0.62
3	1.63	0.24	0.98	1.16	2.09	5.06	2.95	0.23	0.09	0.5	4.84	1.43	3.98	3	2.78	1.43
4	4.44	1.89	1.84	1.6	3.13	2.57	13.8	1.74	0.76	0.98	2.62	8.09	4.05	4.96	4.16	2.2
5	7.11	3.26	3.69	0.67	4.16	2.85	5.58	8.48	1.07	5.96	2.54	2.47	10.7	5.34	4.59	5.03
6	6.62	6.57	4.47	3.21	2.94	1.76	5.66	2.26	2.83	5.42	3.88	2.28	2.91	10.6	4.34	2.99
7	5.99	2.8	7.6	3.2	5.03	1.2	4.26	5.11	1.04	10	4.3	6.94	3.38	3.26	6.13	3.7
8	3.84	3.86	4.94	4.44	6.67	2.58	2.5	4.56	1.25	2.93	6.95	3.6	4.99	2.14	2.57	3.97
9	2.28	3.05	2.8	1.56	8.32	2.66	6.54	2.25	1.12	3.18	5.27	7.45	3.52	3.78	1.3	1.94
10	1.07	2.14	2.69	1.44	3.78	4.28	4.08	2.57	0.76	2.06	4.59	2.07	4.21	2.24	2.48	2.07

Table 17 (cont'd.). Stratified mean catch per tow at age (number), calculated for American plaice from summer bottom trawl surveys in NAFO Division 4V, 1970-1985. The recruitment index (see text for calculation) is also shown for both males and females.

11	0.76	1.02	1.78	0.37	2.92	1.88	4.06	2.48	1.23	1.51	3.29	1.92	1.16	2.76	2.14	1.48
12	0.57	1.91	0.76	0.49	1.4	1.71	2.54	1.65	0.92	1.57	1.77	1.29	1.28	1.13	2.77	2.61
13	0.32	0.62	0.66	0.13	1	0.83	1.29	0.51	0.93	1.39	2.24	0.43	0.8	0.81	1.01	1.56
14	0.7	0.76	0.52	0.12	1	0.53	0.46	0.12	0.37	1.53	3.57	1.85	0.73	0.67	0.62	1.95
15	0.2	0.61	0.33	0.02	0.3	0.38	0.71	0.27	0.32	0.74	1.52	2.57	1.28	0.72	1.07	1.55
16	0.03	0.44	0.59	0.09	0.25	0.31	0.02	0.1	0.13	0.37	0.3	2.03	0.89	0.51	0.32	0.71
17	0.18	0.5	0.18	0.03	0.26	0	0.22	0	0.07	0.23	0.57	0.68	0.34	0.6	0.65	0.34
18	0.24	0.37	0.18	0.02	0.2	0.22	0.1	0.03	0.04	0.08	0.07	0.05	0.32	0.42	0.46	0.56
19	0	0.16	0.02	0	0.07	0.09	0.05	0.15	0.04	0.2	0.32	0.79	0.34	0.21	0.18	0.31
20	0.11	0.05	0.38	0	0.04	0.1	0.1	0		0.1	0.05	0.07	0.51	0.1	0.28	0.28
21	0.11	0.13	0.04	0	0.05	0	0.05	0.04		0.08	0.19	0.15	0.06	0.06	0.12	0.03
22		0.09	0	0	0.03	0					0.06	0.07	0.14	0	0.11	0.1
23		0.05	0.03	0	0	0.11						0.04	0	0.02	0.03	0.06
24		0.13	0	0.03	0.03								0	0	0	
25			0		0.07								0.07	0.08	0	
26			0.02												0	
27			0.02												0	
28															0.02	
NK	0	0.05	0	0.49	0	0.22	0.07	0	0.03	0.04	0.04	0.15	0.44	0	0.02	0
Total	36.2	31	34.8	19.3	45.2	29.6	56.1	32.6	13.1	39.3	49.7	46.7	48.1	44.3	38.8	35.7
Rec. Indices (fem.)			0.46	0.71	0.87	3.13	0.97	0.16	0.16	0.48	2.3	0.9	1.66	1.31	0.99	
Rec. year-class			1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	

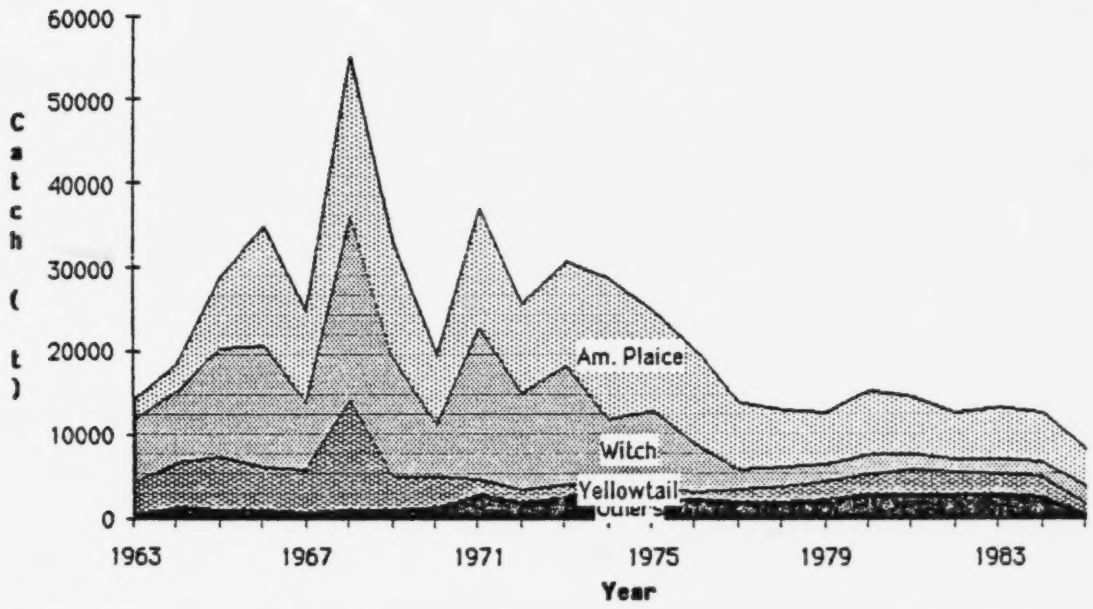

Fig. 1. Total catch of flatfish species (exclusive of the halibuts) in NAFO Divisions 4VWX, 1963-1985.

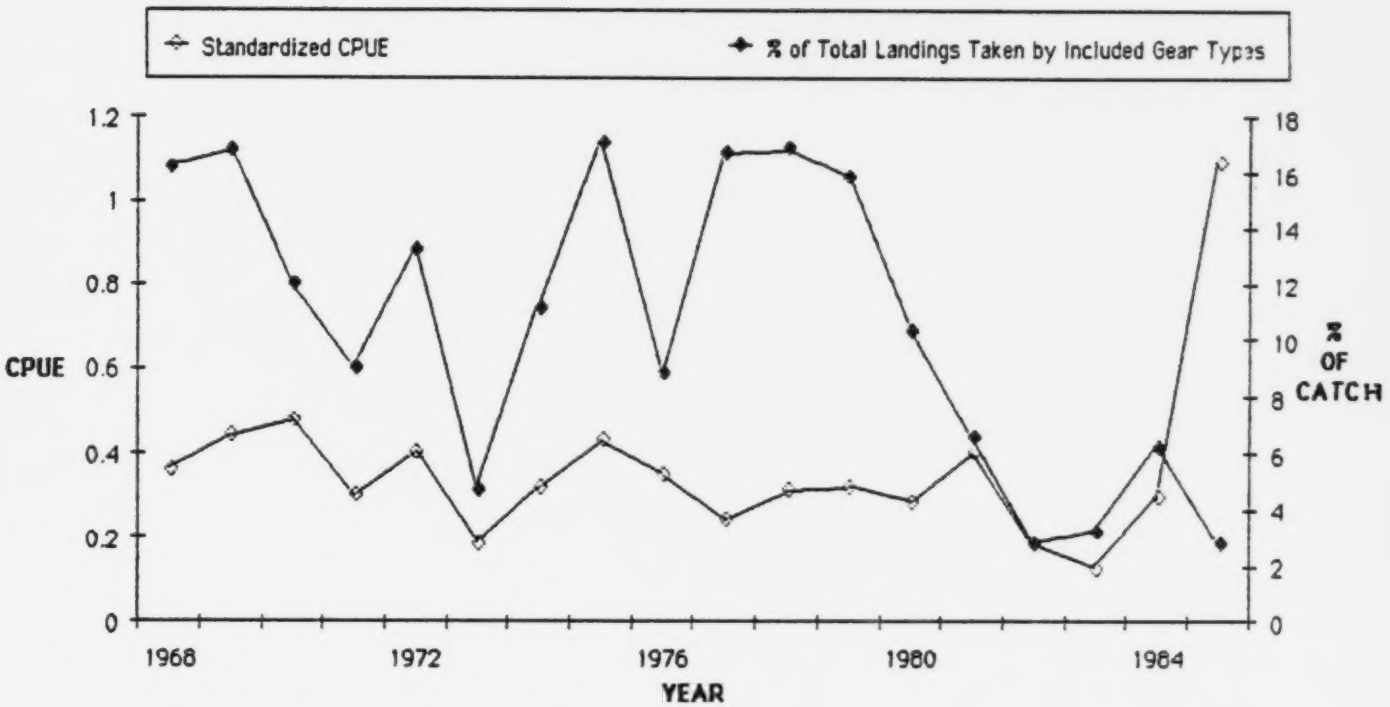

Fig. 2. Standardized catch rate series (including TC4 side trawlers and TC4 and 5 stern trawlers), 4V American plaice, 1968-1985. The percentage of total catch that those gear types accounted for is also shown.

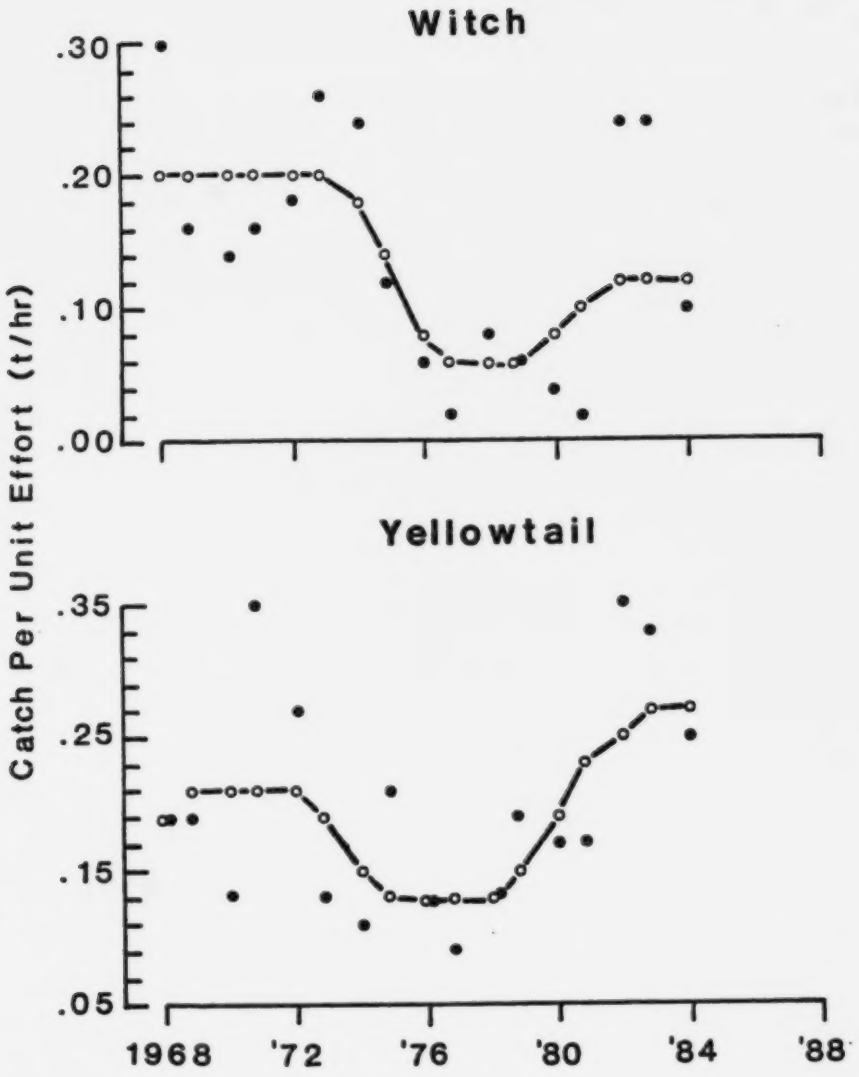

Fig. 3. Trends in catch per unit effort for 4VW witch flounder and 4VWX yellowtail flounder, 1968-1984. CPUE statistics from Canadian side otter trawlers, TC4. Closed circles represent unsmoothed data, and open circles are smoothed values.

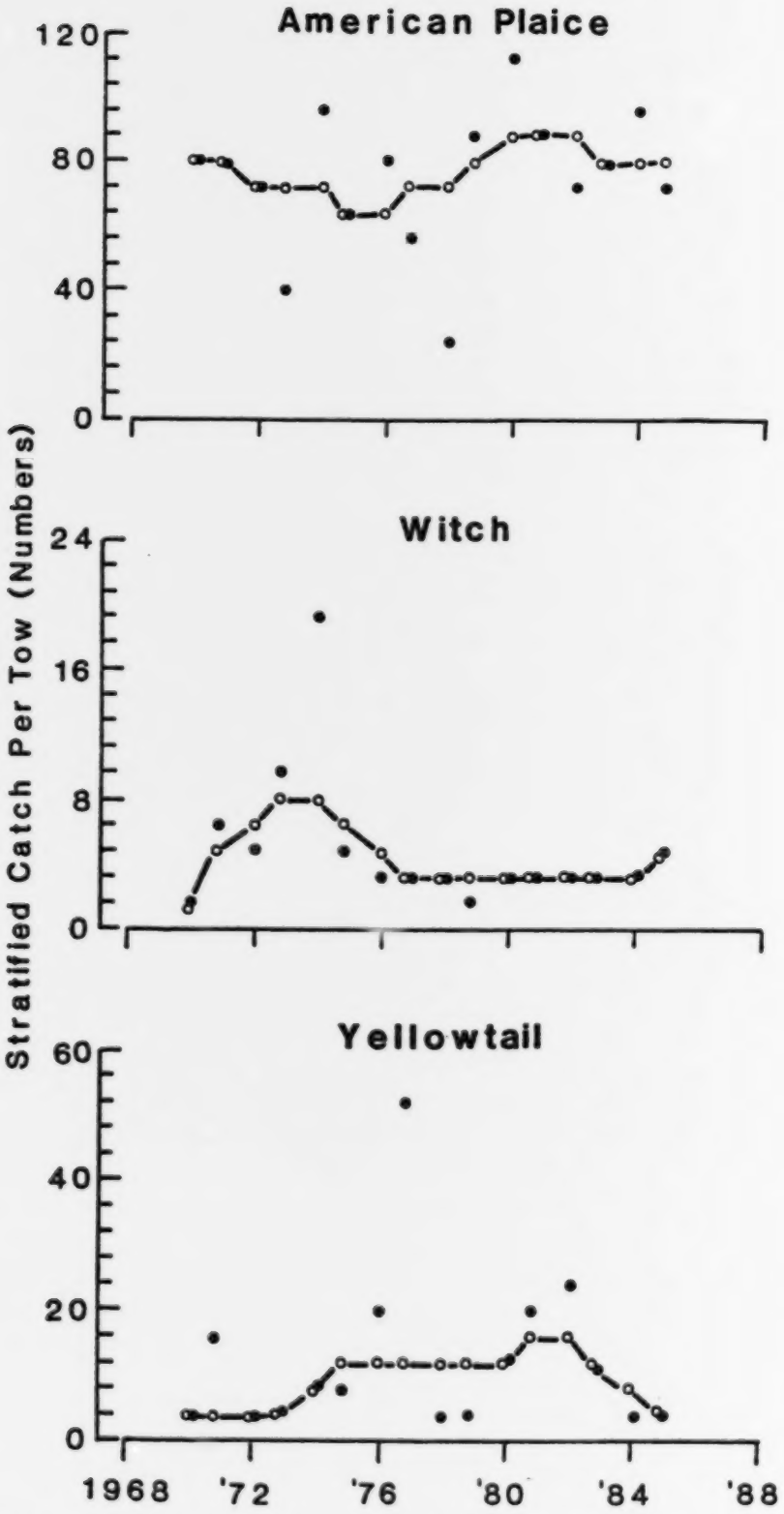

Fig. 4. Trends in stratified catch per tow (numbers caught) of 4V American plaice, 4VW witch flounder and 4VWX yellowtail flounder during summer research cruises, 1968-1985. Closed circles represent unsmoothed data, and open circles are smoothed values.

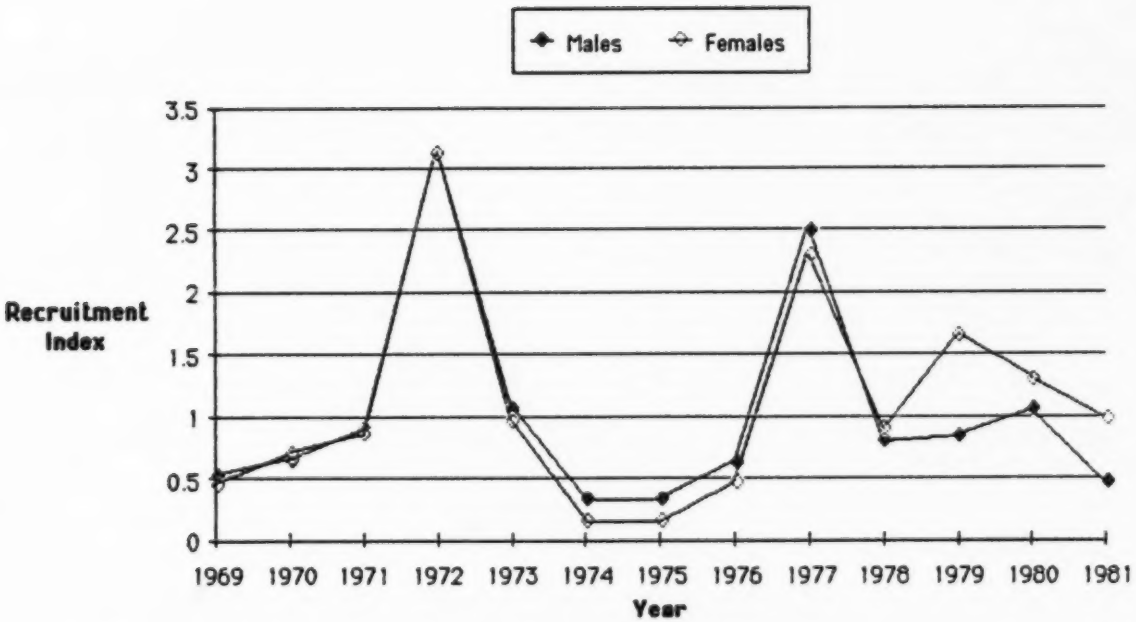

Fig. 5. Recruitment index of 4V American plaice, based on years 3 and 4 of the same cohort (year-classes 1969-1981).

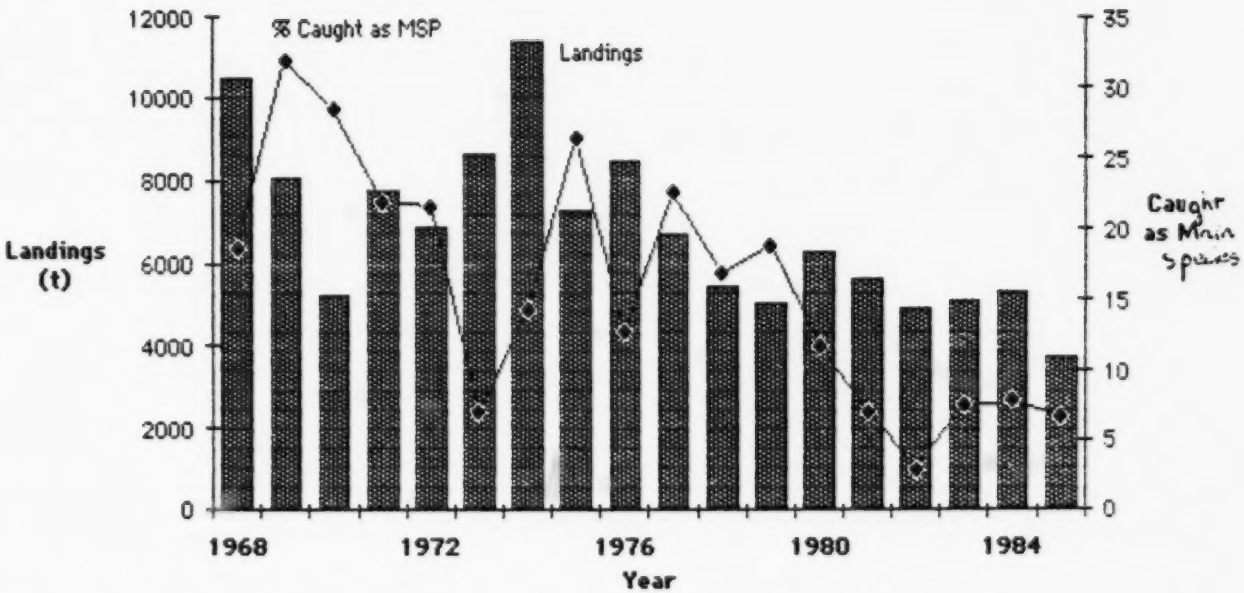

Fig. 6. Total landings of 4V American plaice, compared with percent taken as 'main species caught', 1968-1985.